

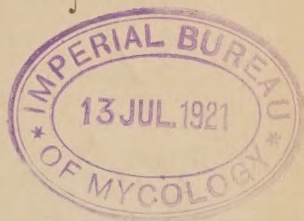
Flora W. Patterson

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GENEVA, N. Y.



NOTES ON VARIOUS PLANT DISEASES.

- I. A BACTERIAL ROT OF ONIONS;
- II. POWDERY MILDEW ON FIELD-GROWN CUCUMBERS;
- III. DODDER ON CUCUMBERS UNDER GLASS;
- IV. IS THE BALDWIN FRUIT SPOT CAUSED BY FUNGI OR BACTERIA?
- V. A *fusarium* LEAF-SPOT OF CARNATIONS;
- VI. *Chaetomium contortum* ON BARLEY SEEDLINGS.

F. C. STEWART.



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NOTES ON VARIOUS PLANT DISEASES.

F. C. STEWART.

SUMMARY.

I. During the season of 1898 a bacterial rot caused heavy losses to the onion growers in Orange Co., N. Y. The onions were found to be affected at harvest time. One or more layers of the onion would be soft rotten while the adjacent layers were sound. Sometimes the rotten layers were on the interior in which case the affected bulbs might be difficult of detection; or the rot might be confined to the outermost fleshy layer, producing the so-called slippery onions. Although this rot is quite certainly due to bacteria it is not readily produced by inoculation with diseased tissue except in the presence of water. This shows that water is an important factor in the rot and that the unusually large amount of rot in 1898 was due to the excessively wet weather which occurred in July and August of that year. Thorough drainage and clean cultivation are recommended as preventive measures.

II. Leaves of field cucumbers affected with a powdery mildew have been received from Athens, Pa. This is believed to be the first record of the occurrence of powdery mildew on field grown cucumbers in America. In greenhouses it is not uncommon. The identity of the fungus is uncertain, but it is probably different from the powdery mildew occurring on squashes and pumpkins.

III. A dodder, *Cuscuta gronovii* Willd., has occurred on greenhouse cucumbers at the Station.

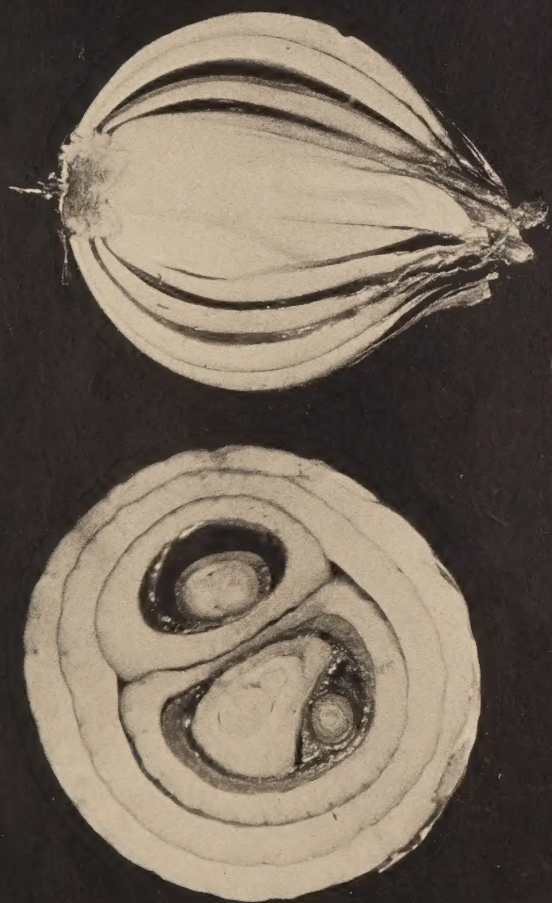
Plants affected with this parasite should be immediately destroyed to prevent it from spreading. It is very aggressive.

IV. The disease of Baldwin apples, known in New York as the Baldwin fruit-spot, is characterized by small brown sunken spots which occur on the fruit about the time it is gathered. Underneath the spots the tissue is light brown and spongy. The diseased tissue contains no fungus hyphæ. In moist chamber the spots do not enlarge and no fungus appears on them. On various culture media the affected tissue produces no growth. The conclusion is that the disease is not caused by fungi or bacteria. However, the work of other investigators indicates that similar spots on the Baldwin and other varieties may be due to parasitic organisms and hence the desirability of greater care in the writing of descriptions.

V. A species of *Fusarium* has been found producing a serious leaf spot disease of carnations at Syracuse. It occurred upon plants so situated that the direct sunlight could not reach them. The fungus gains entrance through breaks in the epidermis made by rust sori. It is not improbable that it may be identical with the carnation stem-rot *Fusarium*.

VI. *Chaetomium contortum* Pk., a rare fungus hitherto found only on lily bulbs on Long Island, has occurred at Geneva under circumstances which aroused the suspicion that it is parasitic on barley seedlings; but an inoculation experiment showed that it is not parasitic.

PLATE II.—SOUND SCALES OF ONION BULB BETWEEN ROTTEN SCALES.



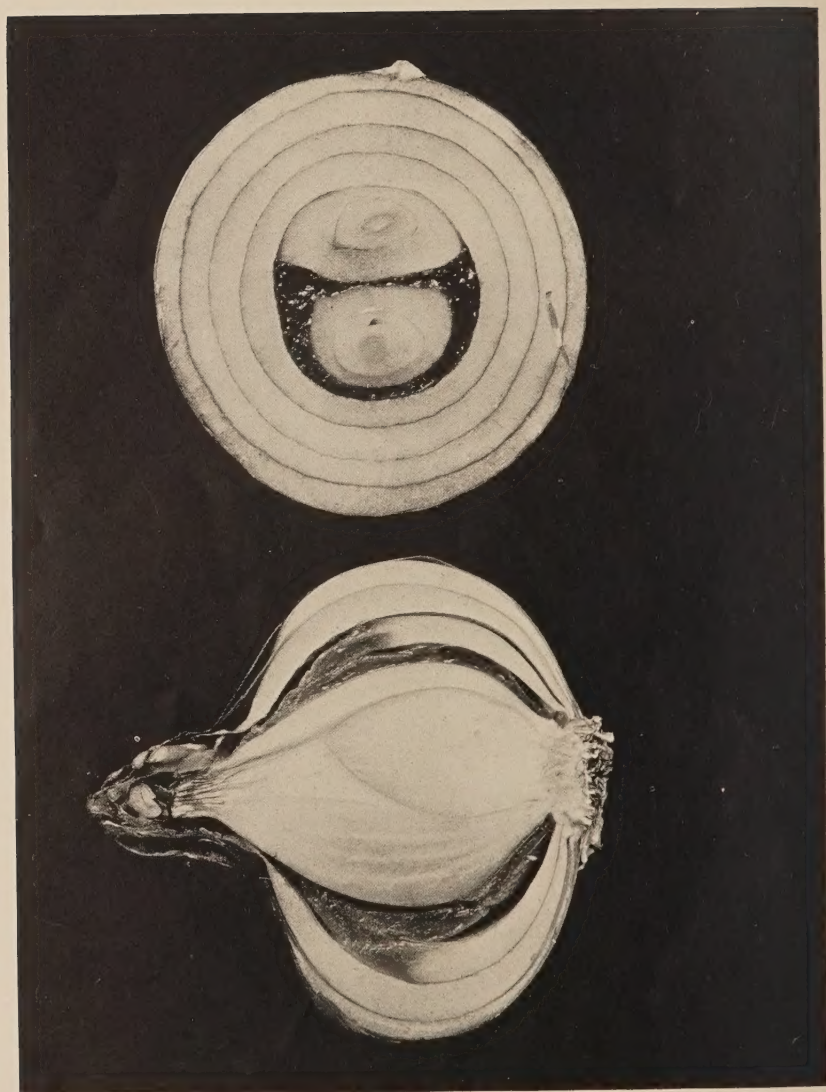


PLATE I. ONIONS AFFECTED WITH BACTERIAL ROT.

I. A BACTERIAL ROT OF ONIONS.¹

In the autumn of 1898 the report came to the Experiment Station that the onions in Orange Co., N. Y., were rotting badly. Upon investigation it was found that in nearly all of the fields in this great onion growing district there was a considerable amount of rot. In many cases from one-third to one-half of the crop had to be rejected on account of it, and the remainder was not readily salable because news of the rot had reached New York City produce dealers who were accordingly suspicious of all onions coming from Orange Co. The same rot was also common in the onion fields of Madison Co., but the losses from it there were not nearly so great as in Orange Co.

The rot was of two kinds: (1) One which starts at the bottom of the onion, and (2) One which starts at the top or "neck." The latter kind of rot was much the more common, constituting perhaps eighty per ct. of the total amount of rot. Where the rot had started at the top the bulbs were frequently sound in appearance but rotten within. Oftentimes it was difficult to determine, before cutting, whether or not a bulb was rotten. In sorting, the customary test for soundness was to press down with the thumbs close about the "neck" of the onion. If it was hard the bulb was sound, but if soft it was usually rotten inside. Onion growers speak of such onions as being "weak in the neck." Upon cutting open the affected bulbs it was generally found that two or three of the outer scales were perfectly sound while the remainder of the bulb was a rotten mass. Frequently a single scale would be entirely rotten from top to bottom and clear around the bulb, while the remaining scales upon both sides of it, were perfectly sound. Such specimens cut crosswise showed the rotten part in the form of a ring. (See Plate I.) Again, a perfectly sound scale would be found between two rotten ones. (See Plate II.) The rot appears never to spread from one scale to another later-

¹ This paper was read at the Columbus meeting of the Society for the Promotion of Agricultural Science, August 22, 1899, and will subsequently be published in the Proceedings of that Society.

ally, and this peculiarity furnishes the most reliable means for the identification of this rot. The organism causing it is unable to pass through the uninjured epidermis of the scale. The passage from one fleshy layer to another is effected at the base of the bulb where they unite. Upon reaching the base of the scale in which it is working the rot commonly stops, and this accounts for the large number of cases in which one or two scales are rotten while the remainder of the bulb continues sound. Under certain conditions the rot does not stop at the base but works its way into the bases of other scales which it then follows upward destroying the whole bulb.

When the rot is confined to the outermost fleshy scale, as is frequently the case, the affected bulbs are called "slippery onions." Some of these are to be found in any season but they are rarely so abundant as to cause material loss.

Microscopic examination of the rotten tissue shows entire absence of fungi but there are swarms of a medium-sized motile bacillus which is without doubt the immediate cause of the rot.

When the rot commences at the bottom of the bulb the whole lower part is soft and eventually the entire onion becomes involved. The rot spreads upward through all of the scales simultaneously. Bulbs so affected show a profuse growth of *Fusarium* about the base and the rotten tissue is filled with the *Fusarium* hyphæ mingled with the previously mentioned bacillus. Although the presence of the bacillus is sufficient to account for this base rot it seems probable that the *Fusarium* aids materially and in some cases it may be the primary cause.

By inquiry among onion growers it was learned that there is in nearly every season a small amount of loss from rot which usually appears in the form of "slippery onions," although both the center rot and the base rot have long been known. The noteworthy fact in connection with the rot in 1898 is the unusually large amount of center rot.

The rot was noticed by farmers when the crop was harvested in August, but the full extent of the trouble was not realized until a month later when the crop was sorted for market. At first it was attributed to injury from hail which fell on July 30; but later the hail theory was rendered untenable by the discovery that there

was considerable rot in fields which had not been struck by the hail. Probably, the wind accompanying the hailstorm was a much more important factor in the rot. In nearly all of the onion fields the tops were much broken by the wind.

Among stored onions kept reasonably dry the rot progresses very slowly, but wet onions rot rapidly, especially if the temperature is high.

All of the evidence obtainable goes to show that this bacterial rot is not new, but that it is an old enemy which found unusually favorable conditions for its development in some peculiarity of the weather during the season of 1898. As yet, no attempt has been made to determine the identity of the organism causing it. It may be the same as the one causing the rot of onions and other plants observed by Halsted² in New Jersey.

The weather records published by the New York State Weather Bureau show that the rainfall in Orange Co. was excessive and the temperature high from the middle of July to the close of August, 1898. At Middletown, which is on the edge of the onion district, the dates upon which rain fell³ during this period were as follows:

RAINFALL AT MIDDLETOWN, N. Y., JULY 18 TO AUGUST 26, 1898.

Date.	Inches.	Date.	Inches.
July 18.....	.31	August 11.....	.80
" 19.....	.51	" 12.....	.08
" 20.....	.90	" 1628
" 21.....	1.85	" 17	1.31
" 26.....	1.04	" 1941
" 28.....	.09	" 23.....	3.08
" 30.....	1.09	" 24.....	.52
August 1.....	1.48	" 2652
" 4.....	1.15		
		Total.....	15.42

In forty days 15.42 inches of rain fell and it was so evenly distributed over the period that the ground was almost constantly wet. The onion fields, being on a low level, were frequently

² Halsted, B. D. The Root Rot of Salsify. Gard. and Forest. 8: 576. N. 1890: Also, Eleventh Ann. Rep. N. J. State Ag. Exp. Sta., 1890: 352.

³ Rep. N. Y. State Weather Bureau, Vol. X, No. 7, p. 11 and No. 8, p. 11.

inundated. In some cases whole fields were covered by the water for a period of from 12 to 36 hours. It is not strange that the onions rotted.

The important rôle which water plays in this rot is shown by the behavior of laboratory cultures. Sound onions were cut open, placed in a moist chamber and inoculated upon the cut surface with bits of rotten onion. At the end of a week there was only a trace of rot at the points of inoculation. Similar inoculations with pure cultures of the *Fusarium* likewise gave negative results. Sound onions, in moist chamber, were bored to the center with an awl and bits of rotten onion introduced into the wounds. At the end of a week there were no signs of rot. This experiment was repeated several times and always with the same result—the onions refused to rot. During these experiments the temperature of the room varied from 21° to 26° C. (70° to 79° Fahr.).

Finally, sound onions inoculated externally with bits of rotten tissue were immersed in sterilized water and placed in an incubator kept at a temperature of 36° C. (97° Fahr.). Other sound onions were treated in the same way except that they were not inoculated. Still others were inoculated by boring to the center and introducing rotten tissue. These latter were then put into the incubator with the others but not immersed in water. At the end of six days all of the onions immersed in water were rotten, including checks; while those which had been inoculated but kept dry were still perfectly sound.

These experiments indicate that one important point in the prevention of this rot is to keep the onions dry. In practice this is to be accomplished by protecting stored onions from rain and by draining the fields so that water will not stand upon them for any length of time.⁴

⁴Since the above was written some observations have been made upon the crop of 1899. The season of 1899 was unusually dry in Orange Co. and yet there were a good many "slippery" onions in some fields. In looking over the onion fields it was observed that some were almost entirely free from weeds while others were thickly overgrown with them. It was in the latter kind of fields that the "slippery" onions occurred. The explanation of this appears to be that the weeds kept the onions wet by retaining the dew and some light showers which fell just before harvest time, thereby furnishing favorable conditions for the rot. Clean cultivation will have a tendency to reduce the amount of rot.

II. POWDERY MILDEW ON FIELD-GROWN CUCUMBERS.

In July, 1891, Humphrey⁵ announced the occurrence of a powdery mildew on cucumbers in America. In his annual report⁶ for that year he gave an extended account of the disease and stated that it had been found on hot house cucumbers at Fitchburg, Mass. and Ithaca, N. Y. His next annual report⁷ contained drawings of the fungus and a brief recapitulation of the matter contained in the previous report. In Cornell Experiment Station Bulletin 31, page 31, Bailey has given a brief account of some experiments on the treatment of cucumber powdery mildew in the greenhouse.

So far as known to the writer, the above mentioned articles constitute the whole of the literature of powdery mildew on cucumbers in America. In the Ninth Massachusetts Report⁸ Humphrey states that in America it is not known to him to attack cucumbers grown in the open air. It is therefore worthy of mention that in September, 1899, we received from F. L. Estabrook, of Athens, Pa., several leaves of field grown cucumbers which were thickly covered with a powdery mildew. Mr. Estabrook states that the mildew made its appearance some time in August and by September 22 was to be found upon every vine in the field and upon all parts of each vine excepting the younger leaves. In almost every case the older leaves near the root were the most severely attacked while the newer leaves toward the tip of the vine were generally free from it. The fungus was conspicuous and occurred chiefly upon the upper surface of the leaves but occasional spots of it were to be found upon the under surface. The fruits were exceedingly bitter and many were misshapen, but this may not have been wholly due to the powdery mildew. The plants were affected to a considerable extent also by downy mildew, *Plasmopara cubensis* (B. & C.) Humph.

⁵ Humphrey, J. E. The Powdery Mildew of the Cucumber. Mass. State Ag. Exp. Sta. Bul. 40: 3.

⁶ Ninth Ann. Rep. Mass. State Ag. Exp. Sta. 1891: 222-226.

⁷ Tenth Ann. Rep. Mass. Ag. Exp. Sta. 1892: 225-226.

⁸ l. c., p. 222.

Since no perithecia were found the identity of the fungus is a matter of conjecture. On his mildewed greenhouse cucumbers Humphrey found the perithecia of *Erysiphe cichoracearum* D C. According to Frank⁹ *Sphaerotheca castagnei* Lev. occurs on cucumbers in Europe, but the most common powdery mildew of cucumbers and other cucurbits in Europe is known only in the conidial form which passes under the name of *Oidium erysiphoides* Fr. Sturgis¹⁰ assumes that the powdery mildew of the cucumber is identical with the one occurring on squash, but to us this appears extremely doubtful for the following reasons: The powdery mildew is common in this country on squash but on cucumber it is rare. During the past two seasons it has been abundant on both squashes and pumpkins in the vicinity of Geneva, but in no case have we observed it upon cucumbers, although cucumber vines have frequently been seen growing among mildewed squashes and pumpkins. *Vice versa*, on Mr. Estabrook's farm at Athens, Pa., a squash vine running among the mildewed cucumbers was entirely free from mildew.

Cucumber growers need not be alarmed at the appearance of this new parasite. It is not likely to become epidemic and in case it should do so it will probably not be found difficult to control.

III. DODDER ON CUCUMBERS UNDER GLASS.

The numerous species of dodder, *Cuscuta*, may be expected to occur on a great variety of plants in the open air, but it is unusual for them to attack greenhouse plants. An interesting case of dodder occurred in the Station cucumber-house last spring. In May, the writer observed a slender, yellow dodder thread twining about a cucumber plant. For a time it was permitted to grow unmolested in order to see what it would do; but it thrived so well and became so aggressive that the man in charge of the greenhouse found it necessary to take precautions to prevent it from spreading to the other plants. Four times during the spring the yellow threads were carefully removed. In spite of this rough treatment

⁹ Frank, A. B. Die Krankheiten der Pflanzen. 2:260. Eduard Trewendt, Breslau, 1896.

¹⁰ Sturgis, W. C. Twenty-First Ann. Rep. Conn. Ag. Exp. Sta. 1897: 214.

it flourished and fruited profusely and succeeded in thoroughly establishing itself upon four of the neighboring plants. The original host plant was greatly enfeebled by it but not killed.

This dodder, which we have determined as *Cuscuta gronovii* Willd., may become troublesome unless dealt with vigorously. We advise the immediate destruction of affected plants.

IV. IS THE BALDWIN FRUIT SPOT CAUSED BY FUNGI OR BACTERIA?

There is a widely distributed and well known disease of the apple in which spots of brown, spongy tissue appear underneath the skin of the ripe fruit. On the surface of the fruit these spots are generally indicated by brown, more or less circular depressions having a diameter of from one-sixteenth to one-fourth of an inch. By different authors it has been given different names; *e.g.*, spot, brown spot¹¹, dry rot¹², bitter pit¹³, stippen¹⁴, etc.

This disease is of uncertain origin. Wortmann¹⁵ thinks it due primarily to insufficient water in the affected parts. Most investigators have failed to find fungus hyphæ in the diseased tissue, but Jones¹⁶ has attributed it to a fungus which Ellis determined as *Dothidea pomigena* Schw. Lamson¹⁷ reports experiments in which the amount of the disease was considerably reduced by spraying with Bordeaux mixture. This, also, indicates a parasitic origin. On the other hand Craig¹⁸ says that spraying does not seem to prevent it, and this coincides with our own limited observations.

The descriptions given by the several authors whose work is mentioned above agree quite closely, and yet it is highly probable

¹¹ Lamson, H. H. N. H. Ag. Exp. Sta. Bul. 65: 106. Illus.

¹² Craig, John. Canada Exp. Farms Report for 1896: 171-172. Illus.

¹³ Cobb, N. A. Ag. Gaz. N. S. Wales, 9 (1898): 683. Illus.

¹⁴ Wortman, Jul. Ueber die sogenannten "Stippen" der Aepfel. Landw. Jahrb., 21 (1892): 663-675.

¹⁵ loc. cit.

¹⁶ Jones, L. R. A Spot Disease of the Baldwin Apple. Fifth Ann. Rep. Vt. Ag. Exp. Sta. 1891: 133-134.

¹⁷ N. H. Ag. Ex. Sta. Bul. 45: 46-47; Bul. 65: 106.

¹⁸ loc. cit.

that they have been dealing with two or more distinct diseases. We have here an illustration of the desirability of more complete descriptions of the gross characters of plant diseases.

During the past season the writer has made an investigation into the cause of one of these fruit-spot diseases of the apple. It is a disease of the Baldwin and is generally known throughout New York State as the "Baldwin spot" or "Baldwin fruit spot." Although it undoubtedly originated somewhat earlier, it was not observed until the fruit was gathered, about October 7. The owner of the orchard estimated that a trifle less than two per ct. of the fruits were affected; however, on individual trees the percentage was much higher than this. The orchard had been thoroughly sprayed four times—twice before and twice after blossoming. It was well cultivated and is in all respects one of the best managed orchards in the vicinity of Geneva.

On the surface of the fruit the spots were very conspicuous. They varied in color from light brown to dark brown. Their general shape was circular, but very few were perfect circles. Sometimes they were quite irregular, but always with the corners well rounded and sharply delimited from the healthy tissue. The spots were slightly sunken, with the epidermis smooth, shiny and unbroken. In size they varied from a mere speck to one-fourth inch in diameter, the majority having a diameter of about one-eighth of an inch. The smallest spots might show no brown color at all, but be indicated merely by a deeper red color of the skin if situated upon the colored part of the fruit, or by a green color if situated upon the lighter portion. The number of spots on individual fruits varied from two or three up to as many as seventy-five, distributed irregularly over the calyx half of the fruit. It is an interesting fact, and one which may throw some light on the cause of the trouble, that the stem half of the fruit is almost invariably free from spots even when they are numerous on the calyx half.

Underneath the surface spots the tissue is light brown, dry and spongy for a distance of one-eighth to three-sixteenths of an inch. This spongy tissue is not bitter to the taste¹⁰ or at least but slightly

¹⁰ This is a point on which the spot disease under consideration differs from the descriptions of Jones and Cobb.

so. At the time the fruits were gathered the spongy tissue was found only underneath the surface spots, but after they had lain some three weeks in the laboratory many brown spots were found distributed irregularly through the flesh of the calyx half of the fruit, but not in the stem half. These spots were irregular in shape, indefinite in outline and in many cases entirely surrounded by healthy tissue.

Several other varieties of apples in this State are affected with spots similar to those on the Baldwin, but the following study was confined to the Baldwin spot here described, and the conclusions apply to this one form only.

Microscopic examination of the affected tissue revealed no fungus hyphæ and no bacteria which could be definitely demonstrated as such. Commencing October 7, two of the affected Baldwins were kept for 21 days in a moist chamber at a temperature of 65° to 74° Fahr. During this time the spots did not enlarge (externally, at least), no fungus appeared upon them and they did not increase in number upon the surface although they did increase in number *within* the fruit.²⁰ When these apples finally rotted the rot started on the stem half instead of the spot-affected calyx half. At another time, two affected apples were kept in a moist chamber for 18 days with the same results.

Next, an experiment was made to determine if the diseased tissue would produce any growth when placed in culture media. Four Petri dishes²¹ containing potato agar slightly acidified with lactic acid were each inoculated at three different points with small pieces of the brown spongy tissue. This gave twelve points of inoculation with material from twelve different spots. The cultures were kept at the room temperature, about 70° Fahr. At the end of eight days one point of inoculation was overrun by a fungus which had gained admission to the culture by accident.

²⁰ The reason for believing that the spots increased in number within the fruit is as follows: When the apples were taken from the trees many of them were cut open and in no case were the spots found except immediately under the epidermis; but after affected apples from the same lot had been off the trees for about three weeks they universally showed brown spots scattered through the flesh quite to the core.

²¹ Two dishes acidified at the rate of one drop of 50 per ct. lactic acid to 10 c. c. agar and the other two dishes at double this rate.

The other eleven points of inoculation were entirely free from growth of any kind.

On November 1 six tubes of neutral beef-peptone agar were inoculated with small pieces of the brown, spongy tissue taken from six different spots, and then poured into Petri dishes. At the end of eight days the only growth in the six dishes consisted of one fungus and two yeast colonies which were evidently intruders. We now tried cultures in an atmosphere devoid of oxygen. Six tubes were used—two of potato agar, two of beef-peptone agar and two of beef-peptone agar containing two per ct. of lactose. One tube of each kind was slightly acidified with malic acid and the other left neutral. The six tubes were inoculated with bits of spongy tissue from six different spots, thoroughly shaken and placed in a large bottle from which the oxygen was then removed by means of pyrogallie acid and potassium hydroxide solution. These cultures were kept at a temperature of about 80° Fahr. for one week but they produced no growth whatever.

Finally, at the suggestion of Mr. H. A. Harding, Station Bacteriologist, we tried apple-peptone agar²² as a culture medium. Three tubes of this medium carefully neutralized with sodium hydroxide, and three tubes unneutralized were inoculated with the spongy tissue and kept 24 days in air at a temperature of about 80° Fahr. Six other tubes of the same medium, three neutralized and three unneutralized, were inoculated and kept for the same length of time at a temperature of about 80° Fahr. in an atmosphere devoid of oxygen. No growth appeared in any of the twelve tubes.

From the result of this study we conclude that the form of apple fruit-spot described above is not caused by fungi or bacteria, but what the real cause may be we are not prepared to state.

Wortmann²³ observed that starch is present, often in considerable quantity, in the brown, spongy tissue, while the surrounding healthy tissue is almost, if not wholly, destitute of starch. We find that the spongy spots lying just beneath the epidermis gen-

²² Baldwin apple,	400 gms.
Witte's peptonum siccum, 10 "	
Agar,	15 "
Water,	1 liter.

²³ Loc. cit., p. 663.

PLATE III.—DODDER ON CUCUMBERS.



worst affected leaves were dying. The *Fusarium* was evidently parasitic on the leaves, but a careful examination revealed the fact that in every case the spots originated in a rust²⁴ sorus. It appeared that the *Fusarium* was unable to attack the uninjured leaf, but when the epidermis was broken by rust it was able to enter and bring about decay of the leaf tissue. It is improbable that the *Fusarium* is parasitic upon the rust²⁵.

The writer has occasionally observed *Fusarium* attacking injured leaves and stems of carnations and the spore masses of a similar *Fusarium* are common on the stems of carnations affected with that form of stem-rot commonly known as dry rot or die back²⁶; but we have never before known *Fusarium* to produce a genuine leaf-spot of carnations. Inoculation experiments may show that this *Fusarium* is identical with the one causing carnation stem-rot.

The plants were grown under conditions exceptionally favorable to the attack of fungi. They were so situated that direct sunlight never reached them. However, they were doing fairly well and were free from disease with the exception of the *Fusarium* leaf-spot and a moderate attack of rust.

²⁴ *Uromyces caryophyllinus* (Schrank) Schroet.

²⁵ In this connection it may be mentioned that Mr. F. H. Blodgett, Assist-Botanist and Entomologist, observed at Mattituck, N. Y., last August, a *Fusarium* growing abundantly on the uredo sori of *Puccinia asparagi* D C. However, in this case, the *Fusarium* was not confined so strictly to the rust sori, but occurred also upon the so-called leopard spots and sometimes even upon the uninjured asparagus stems.

²⁶ For an account of the *Fusarium* stem-rot of carnations see: Sturgis, Wm. C. Preliminary Investigations on a Disease of Carnations. Twenty-first Ann. Rep. Conn. Ag. Exp. Sta. 1897: 175-181. Also, Stewart, F. C. The Stem-rot Diseases of the Carnation. Bot. Gaz., 27: 129-130.